DARPA Advanced Energy Technologies

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Portable Power — Opportunities

★ **Batteries:** significant improvements over existing systems;
>> 2X Specific Energy/Power

★ **Fuel Cells, Direct Methanol**

Methanol Crossover
Cathode Catalyst Activity and Methanol Tolerance
Anode Catalyst Activity
Membrance Electrode Assembly Processing

★ **Fuel Cells, Alternative Fuel Options and Concepts**

★ **TPV and AMTEC**

Low Cost and Efficient PV Cells
Efficient TPV Cavity Designs
Compact AMTEC Designs
Efficient Fuel Combustion at Low Flow Rates
High Temperature Heat Recuperation

Mobile Electric Power — Opportunities

★ **Fuel Reforming**

Size
Efficiency
Sulfur Removal and/or Tolerance
Hydrogen Purity
Fuel Cell Integration

★ **Customize for the Military**

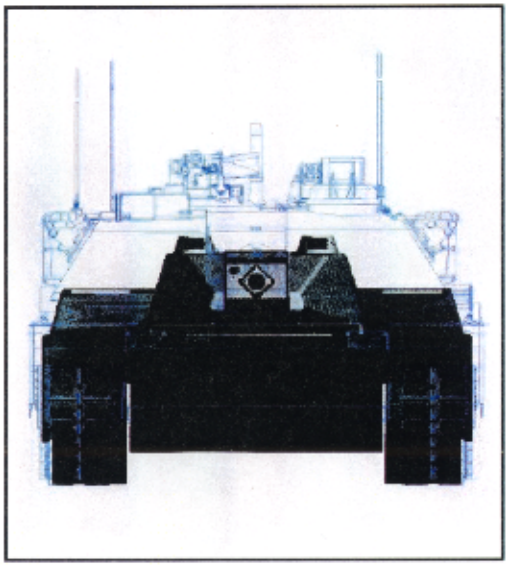
System Size and Weight
System Efficiency
Environmental Isues:
    shock, vibration, temperature, altitude, salt spray, dust, etc.
Signature:
    acoustic, thermal, etc.
Operation and Maintenance

Advanced Energy Technologies

Defense Sciences Office

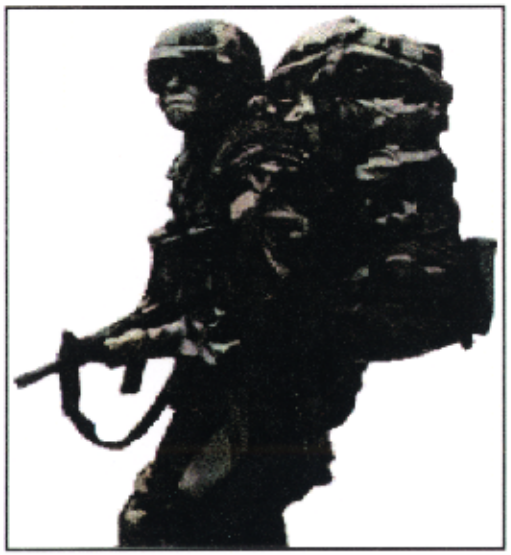
Power for the Military

Mobile Electric Power
2 - 100 kW



- Silent Watch
- Field Power Stations

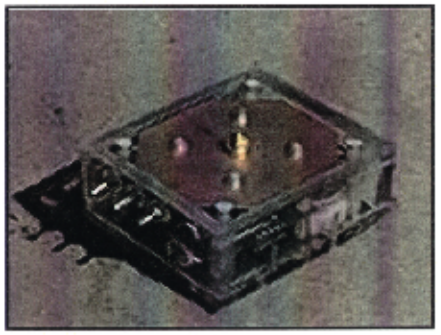
Portable Power
50 - 500 W



- Battery Replacement
- Micro-Climate Cooling
- Battery Charging

Energy Harvesting
< 5 W

Micro - Internetted Unattended Ground Sensor



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- Ground Sensors
- Micro - Robots

Mobile Electric Power 2 - 100 kW Fuel Reformer Demonstrations

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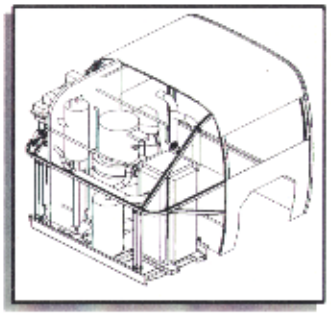
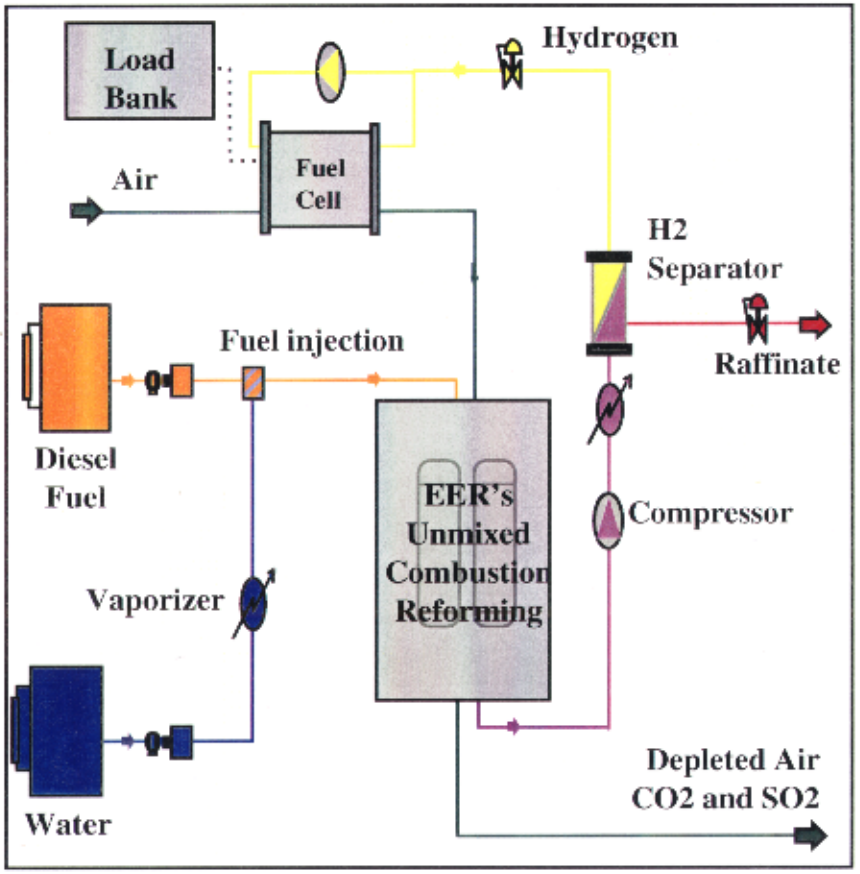
100 kW PAFC

- 14 kW Tested
- 100 kW Fabrication



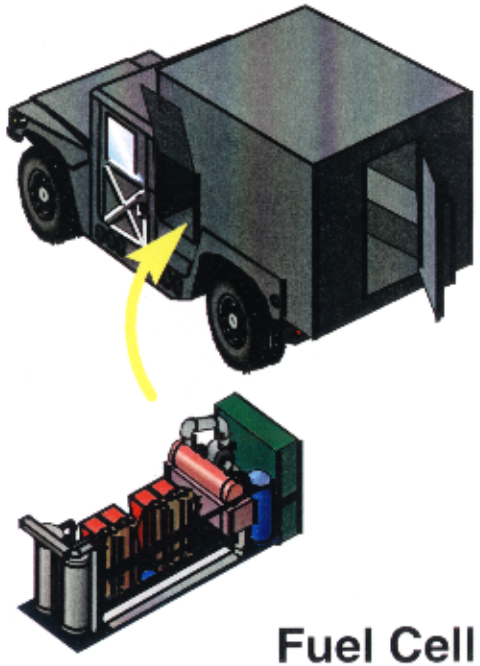
- Georgetown U. Bus

20 kW PEMFC



10 kW SOFC

Multipurpose Shelter



Fuel Cell

System Mass vs. Mission Duration
Mobile Electric Power - 10 kW (Logistics Fuel)

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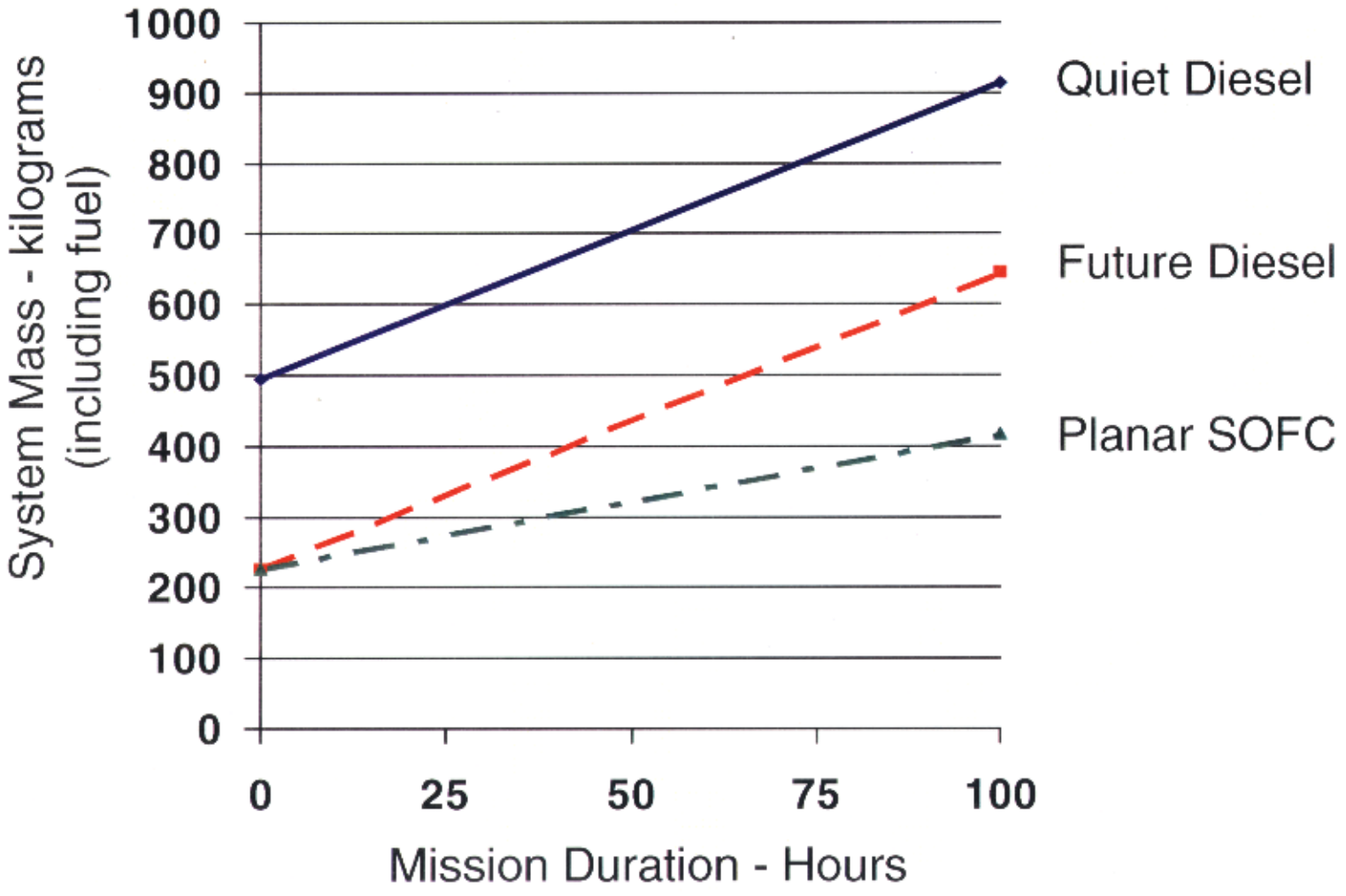

Energy Conversion vs. Energy Storage

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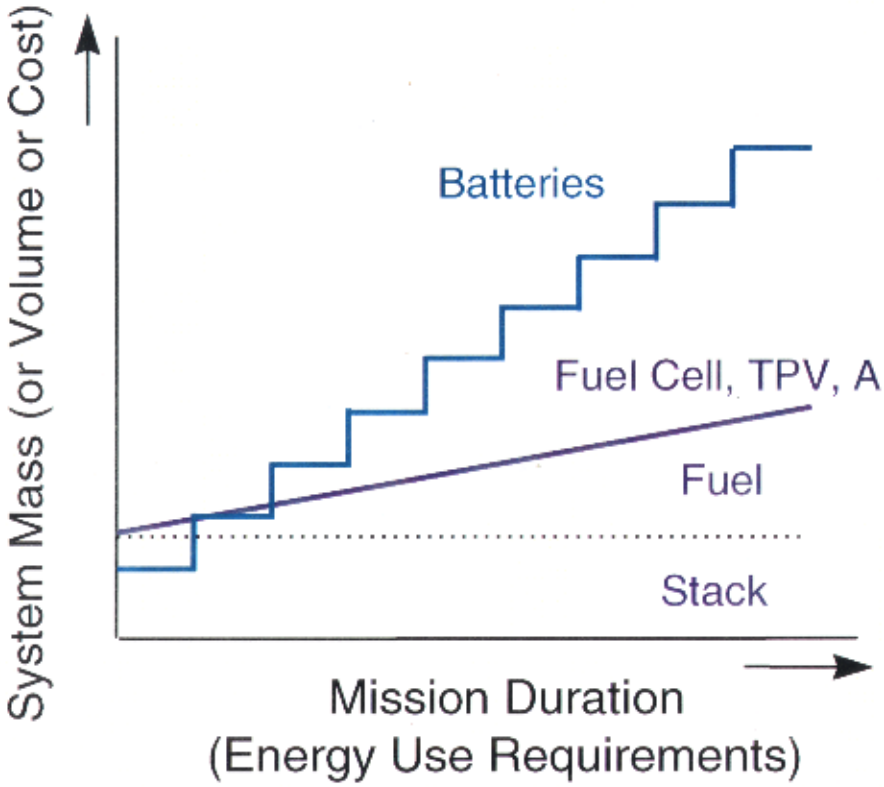

Energy Density of Selected Fuels and Batteries

Fuel:	Energy Density
Diesel Fuel/Jet Fuel	12,000 Wh/kg
Methanol	5,000
High Explosive	1,000

Battery:	
Primary Battery (est. max.)	500
Rechargeable (est. max.)	200
Li/SO_2 Battery (primary)	176
Alkaline Battery (primary)	80
Nickel-Cadmium (secondary)	40

Driving Force: Substantially decreased size, weight, and cost with improved safety and environmental compliance → Increased force mobility

Portable Power
50 - 500 W

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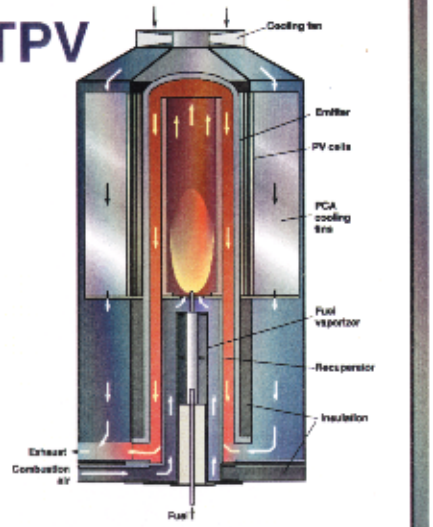
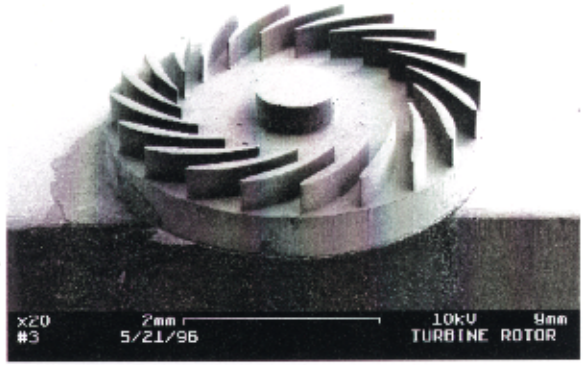
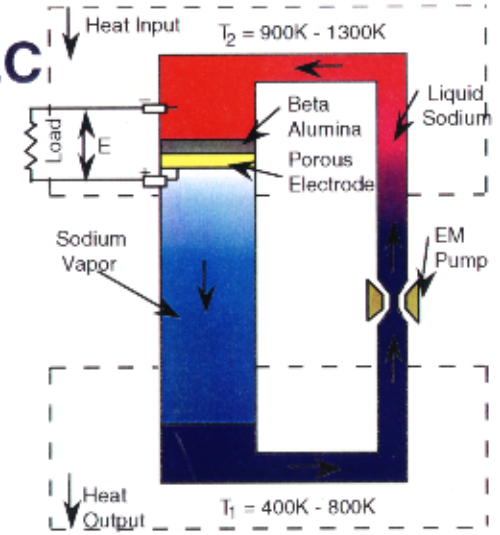
TPV



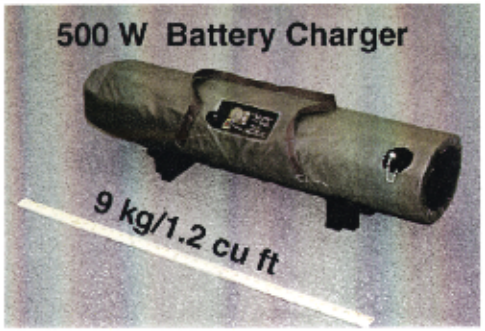
micro-Turbine Generator



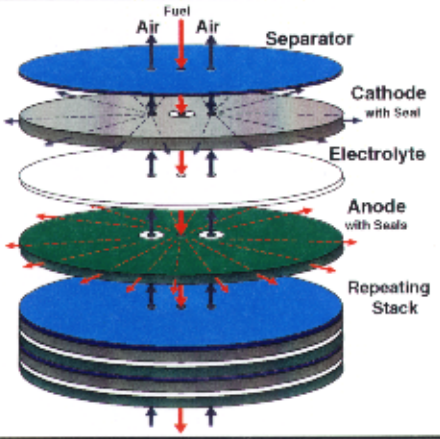
AMTEC



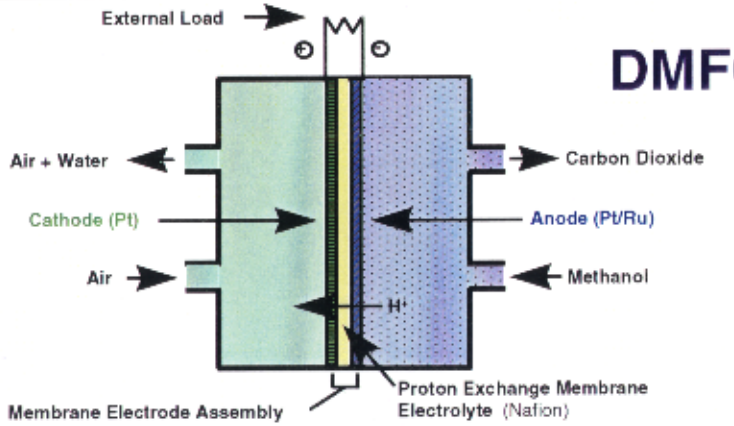
500 W Battery Charger



Planar SOFC



DMFC



System Mass vs. Mission Duration
Portable Power - 500 W

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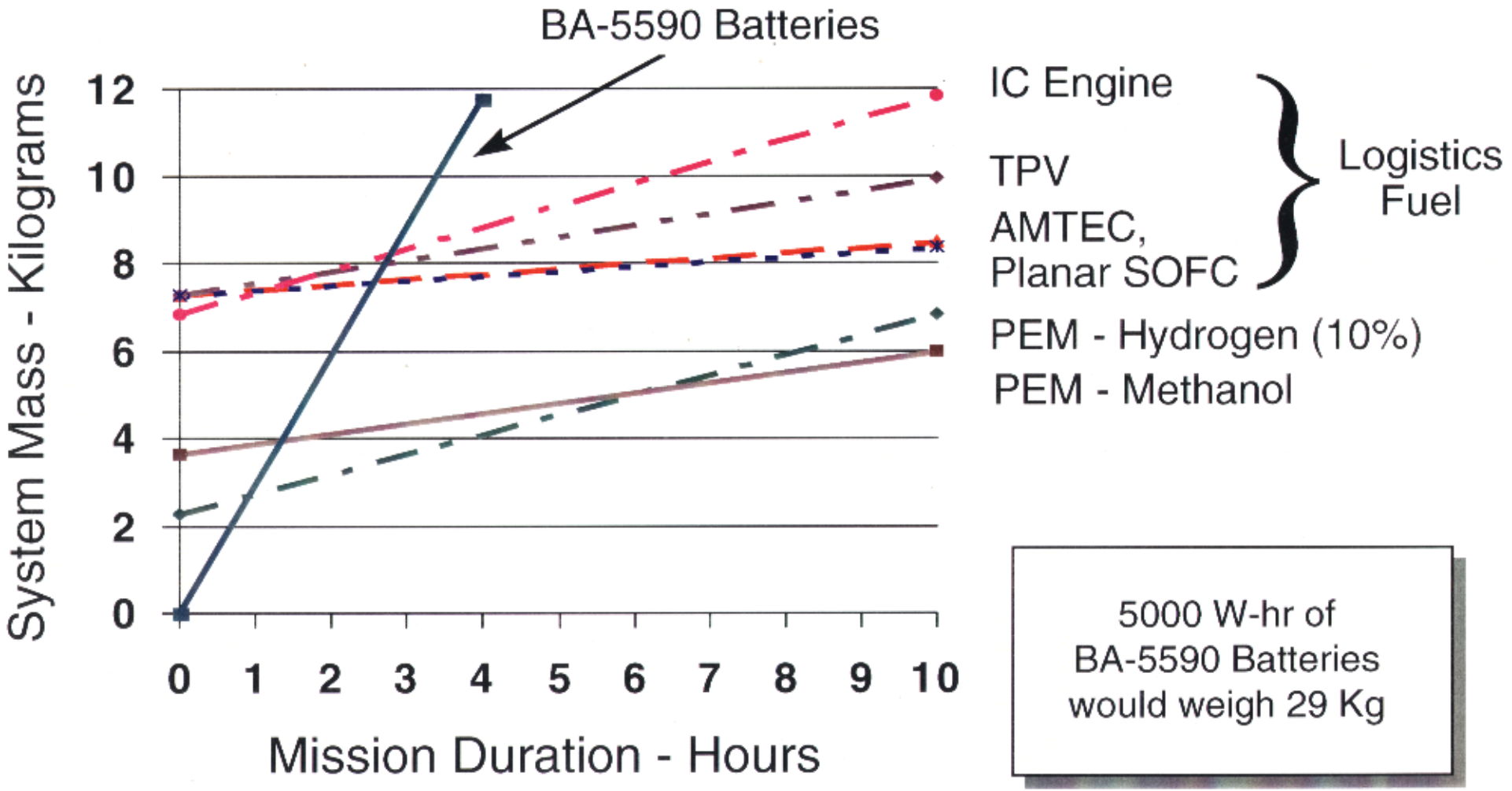

5000 W-hr of
BA-5590 Batteries
would weigh 29 Kg

MIT Micro Turbine Generator Performance Comparison

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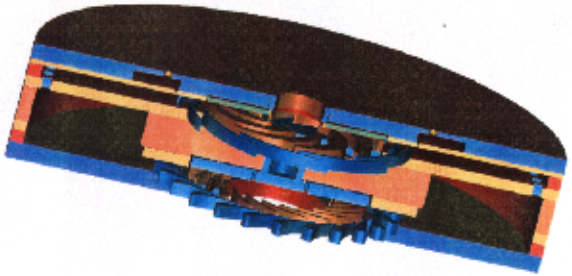

	μ Turbogen*	BA-5590 ($LiSO_2$) Battery
Power Output	50 W	50 W
Energy Content	175 W hr	175 W hr
Weight	50 g	1100 g
Volume	50 cc	880 cc
Specific Energy	3500 W hr/kg	175 W hr/kg
Energy Density	3 W hr/cc	0.2 W hr/cc

* Effort lead by MIT; all values include fuel

The Portable Power Burden for 10 kW-hr of Electrical Energy

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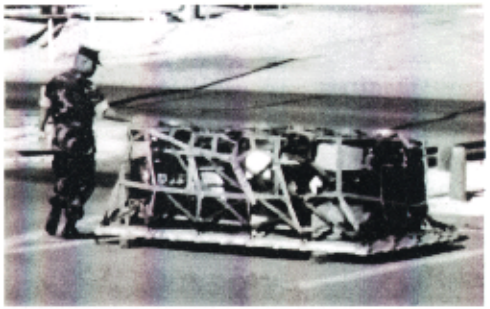
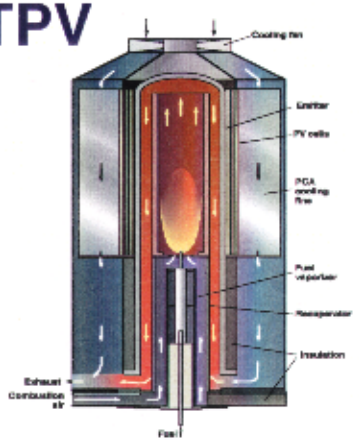
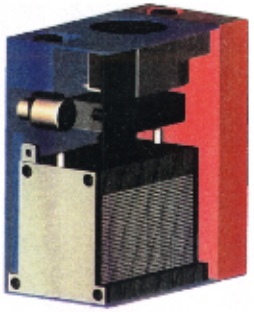
1996	2002	2010
60 Kg	**15 Kg**	**4 Kg**



Batteries

TPV

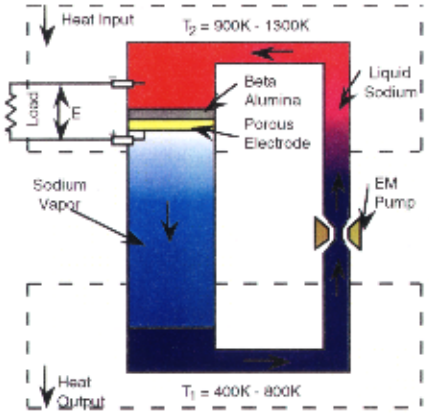


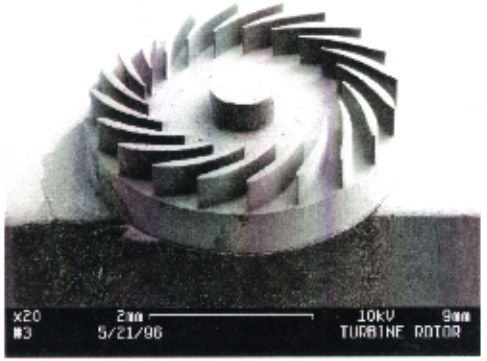


DMFC

(BA-5590 Equivalent)

AMTEC





Microturbines